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EVALUATIONS ON ACCELERATING WOOD DECOMPOSITION IN THE FIELD

by

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ABSTRACT

Treatment of pieces of Douglas-fir with nitrogenous chemicals, a mixture of 2,4-D and 2,4,5-T, or a plastic spray failed to accelerate decay of wood specimens in the field. Therefore, adding these various chemicals is not recommended treatment for residue reduction.

Keywords: Slash disposal, decay fungi (wood)

INTRODUCTION AND OBJECTIVE

Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco var. *menziesii*) logging residue may impede regeneration and cause fire hazard problems in Pacific Northwest forests. Since decay of Douglas-fir is relatively slow, these problems can persist for many years (Childs 1939, Wagener and Offord 1972). The land manager neither long postpones regeneration nor tolerates fire hazards on harvested lands. Acceleration of decay offers one way to reduce residues.

The objective of this study was to see if decomposition could be accelerated by treating Douglas-fir wood with varying amounts of ammonium phosphate, urea (45-percent), asparagin, a mixture of equal amounts of 2,4-D and 2,4,5-T, or a plastic spray for moisture retention.

Wood decay is caused by enzymes secreted by saprophytic fungal mycelium (Boyce 1961). The fungus penetrates between and into cells and is capable of breaking down the wood and using it for food (U.S. Forest Products Laboratory 1974). Wood is composed mainly of cellulose and hemicellulose, which account for 60 to 70 percent of the cell wall, and lignin which accounts for 15 to 35 percent (Panshin and DeZeeuw 1964).

Nitrogen usually comprises less than 0.1 percent of the dry weight of wood (Merrill and Cowling 1966). Kaufert and Behr (1942) report that wood treated with urea is more susceptible to decay than untreated wood. Others (Cartwright and Findlay 1950, Curtis 1957, Schmitz and Kaufert 1936, Zycha 1940) have shown in laboratory tests that adding nitrogenous substances increases the rate of decay.

Pruning with chemicals 2,4-D and 2,4,5-T accelerates natural pruning by deadening the branches of hardwoods (MacConnell and Kenerson 1964). Personnel of the Fuel-Break Project[1] observed that shrubs killed with 2,4-D decay more rapidly than fire-killed shrubs.

Curtis (1957) reports that a solution of 2,4-D and 2,4,5-T in diesel oil with fertilizer applications has been used to help accelerate decay of stumps. No work has been done to see if decomposition of wood is increased by treatment with a solution of only 2,4-D and 2,4,5-T.

STUDY PROCEDURE

Field

Study plots were established on a test area located on the Estacada Ranger District, Mount Hood National Forest, Oregon. The area was in a Douglas-fir and western hemlock stand (*Tsuga heterophylla* (Raf.) Sarg.) with no underbrush on a north-facing slope.

Each plot was a circular milacre. Ten plots, one for each of nine treatments, plus one control were located in a line with at least 3 feet (0.914 m) but not more than 6 feet (1.8 m) between plots. This configuration of 10 plots was replicated four times. The four 10-plot series were laid out in a random compass array extending from a point near the center of the experimental site.

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[1] Headquartered at the Forest Fire Laboratory, U.S. Forest Service, Riverside, California.

No 10-plot series was closer than 10 feet (3.048 m) to another. Sapwood samples, 2 inches x 2 inches x 4 inches (5.08 cm x 5.08 cm x 10.16 cm), were cut from a felled Douglas-fir bole and installed in the plots in September. Six wood samples were placed in each plot within a week after cut and treated immediately after. Each sample was placed horizontally directly beneath the duff and litter layer in contact with the soil surface. Treatments were randomized within each 10-plot series and exposed to one of the 10 treatments. A quart (0.9463 l) of water was used as the carrying agent for the nitrogenous compounds and sprinkled directly on the samples of wood. A quart of water was applied to each control plot.

The chemicals used and amounts of each application are listed below.

Seven untreated pieces of wood were stored in a room with uncontrolled temperature and humidity for future comparison with the treated blocks.

Blowdown destroyed 8 of 40 plots, so samples were collected from only 32 plots. The samples were retrieved from the field after being exposed for 33 months, placed in plastic bags, and shipped to University of Washington for analysis.

Treatment	Chemical compound	Amount	Per acre equivalent
1	Ammonium phosphate	0.25 lb (0.113 kg)	40 lb N (44.83 kg/ha)
2	Ammonium phosphate	0.75 lb (0.34 kg)	120 lb N (134.50 kg/ha)
3	Urea	0.089 lb (0.04 kg)	40 lb N (44.83 kg/ha)
4	Urea	0.267 lb (0.121 kg)	120 lb N (134.50 kg/ha)
5	Asparagin	0.167 lb (0.076 kg)	40 lb N (44.83 kg/ha)
6	Asparagin	0.5 lb (0.227 kg)	120 lb N (134.50 kg/ha)
7	2,4-D and 2,4,5-T	0.0015 gal (0.00568 l)	3 lb each herbicide (3.363 kg/ha)
8	2,4-D and 2,4,5-T	0.003 gal (0.011 l)	6 lb each herbicide (6.725 kg/ha)
9	Plastic spray (moisture retention)	7 oz (198.447 g)	--
10	Water (control)	1 qt (1.946 l)	--

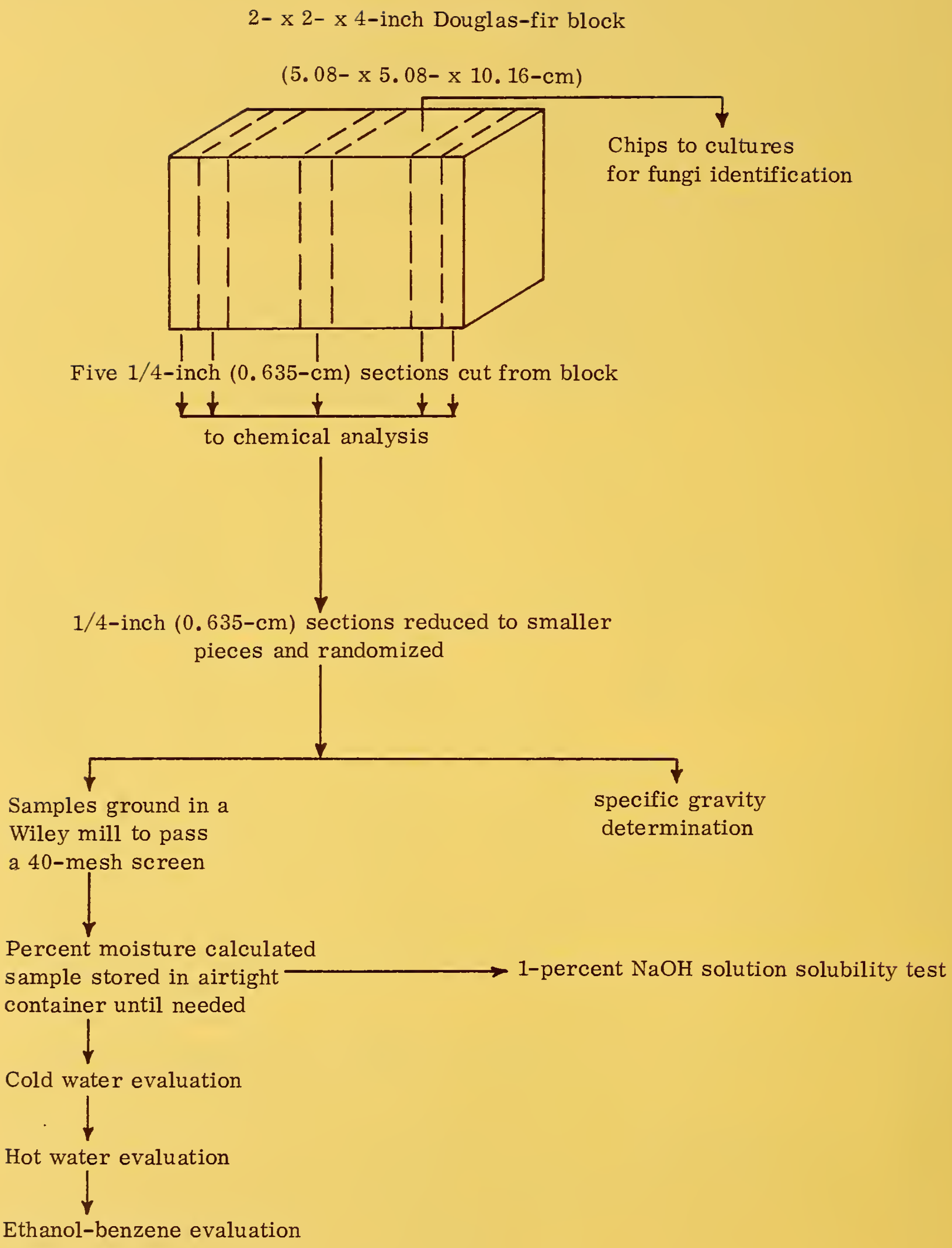
2- x 2- x 4-inch Douglas-fir block
(5.08- x 5.08- x 10.16-cm)
Chips to cultures
for fungi identification
Five 1/4-inch (0.635-cm) sections cut from block
to chemical analysis
1/4-inch (0.635-cm) sections reduced to smaller
pieces and randomized
Samples ground in a
Wiley mill to pass
a 40-mesh screen
specific gravity
determination
Percent moisture calculated
sample stored in airtight
container until needed
1-percent NaOH solution solubility test
Cold water evaluation
Hot water evaluation
Ethanol-benzene evaluation

Figure 1.--*Flow chart for solubility and specific gravity tests.*

Laboratory

Samples were prepared for analysis by cutting five 1/4-inch (0.635-cm) sections from each piece of wood. One section was taken from the middle and two from each end of the wood samples (fig. 1). The five sections were dried at 60°C (140°F) for 72 hours to stop decomposition and to prepare the pieces for grinding. After drying, each section was cut into smaller pieces and all pieces from the five sections were mixed together. About 0.21 ounce (6 g) were removed for determining specific gravity. The remainder was ground in a Wiley mill[2] to pass a 40-mesh screen and then placed in an airtight container. Samples were removed from the container as needed for analysis and solubility.

As wood decays, depolymerized and modified fragments of wood extractives, hemicellulose, cellulose, and lignin become more soluble in neutral solvents and sodium hydroxide (NaOH) (fig. 2).

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[2] Mention of product by name does not imply endorsement by the U. S. Department of Agriculture.

Figure 2.--Effect of decay on increasing solubility of wood components.

	SOUND WOOD COMPONENTS	DECAYED WOOD COMPONENTS
SOLUBLE IN:		
Neutral solvents*	Extractives	Extractives Hemicellulose Cellulose
1-percent NaOH	Extractives Hemicellulose	Extractives Hemicellulose Cellulose
INSOLUBLE IN:		
Neutral solvents*	Hemicellulose Cellulose Lignin	Lignin⁄
1-percent NaOH	Cellulose Lignin	Lignin⁄

*Cold water, hot water, and ethanol benzene.
⁄ Soluble in trace amounts only.

Therefore, TAPPI solubility and specific gravity tests (Technical Association of the Pulp and Paper Industry 1974) were made to determine the extent of decay in each block. The standard TAPPI tests, listed with each solubility stage, are:

Solubility test	TAPPI procedures
Moisture percent	T11M - 59
Cold water	T1M - 59
Hot water	T1M - 59
Ethanol-benzene	T6M - 50
1-percent NaOH	T4M - 59
Specific gravity	18M - 53

The sequence of analysis is outlined in figure 1. Two of each TAPPI test for each evaluation were made for each block.

Samples were taken from the pieces of wood for culture of decay organisms. A sterile razor blade was used to expose a fresh area on each block sampled. Small chips of wood were removed from each exposed area with sterile microforceps. Each chip was placed on Martin's dextrose-peptone media fortified with 0.00123 ounce (0.035 g) of rose bengal and 30.0 micrograms per milliliter (0.0005 oz per pt) of streptomycin sulfate and incubated (temperature 24°C-28°C, or 75.2°F-82.4°F). Fungi that did not sporulate or those not readily recognizable were transferred to plates of 2-percent malt agar media and incubated until they could be identified.

An analysis of variance was performed comparing solubility and specific gravity tests to determine any significant difference in decay among the treated blocks and control test blocks in the test area. The 95-percent probability level was used for judging significance.

RESULTS

All blocks of wood appeared solid with little or no evidence of decay. However, the laboratory tests revealed some decomposition had taken place. Although there was variability among blocks of wood, the total solubility was about 32 percent for treated and control specimens. Neutral solvents accounted for 8.7 percent and 1-percent NaOH, 23.26 percent (table 1).

Table 1.--*Solubility of test pieces, based on moisture-free weight*

Mean	Solubility in				
	Cold water	Hot water	Ethanol benzene	1-percent NaOH	Total
	- - - - - - - - - - *Percent* - - - - - - - - - -				
Mean of all treatments	4.57	2.67	1.46	23.26	31.96

The pieces of wood stored in the room showed a mean total solubility of 18.76 ± 6.91 at the 95-percent confidence level. The results showed there was a difference between samples collected from the field and those stored in the room. However, an analysis of variance indicated there was no evidence of any significant difference (at the 95-percent confidence level) among the various treatments for pieces collected from the field.

The values of the two laboratory tests for each treatment varied less than 1 percent, so each mean was used for the analysis of variance computations.

The micro-organisms isolated from wood chips were:

Isolate	Frequency (percent)
Penicillium spp.	28
Trichoderma spp.	21
Sterile mycelium	16
Bacteria	6
Basidiomycete	6
Sporotrichum spp.	6
Red mucor spp.	4
Sporothrix spp.	4
Cylindrocladium spp.	3
Trichosporon spp.	3
Acromoniella spp.	1
Cephalosporium spp.	1
Rhizopus spp.	1

Of the 67 percent of the microorganisms isolated above in the class Imperfect Fungi, species of *Penicillium* and *Trichoderma* accounted for 73 percent. Sterile mycelium (16 percent) were those fungi that did not sporulate and did not show the presence of clamp connections. The Basidiomycetes were identified on the basis of clamp connections exhibited on the vegetative hyphae.

CONCLUSIONS

As expected, the stored, untreated, air-dry samples exhibited the lowest solubilities. The treated and control pieces of wood showed an increased solubility of about 13 percent, indicating decomposition was taking place. However, decomposition was not significantly influenced by the various chemical treatments as shown by the analysis of variance. Therefore, addition of the nitrogenous materials tested, a solution of 2,4-D and 2,4,5-T, or a plastic compound is not recommended treatment for residue reduction.

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